A taxonomic update of *Petrophile* sect. *Arthrostigma* (Proteaceae)

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Abstract

Rye, B.L. and Hislop, M. A taxonomic update of *Petrophile* sect. *Arthrostigma* (Proteaceae). *Nuytsia* 15(3): 457–483 (2005). *Petrophile* sect. *Arthrostigma* (Endl.) Benth. is described, *P. teretifolia* R. Br. is chosen as its lectotype, and a key is given for all members of the section. *Petrophile filifolia* R. Br. and *P. juncifolia* Lindl. are reinstated. Descriptions are also given for five new taxa, *Petrophile filifolia* subsp. *laxa* Rye & Hislop, *P. pilostyla*, *P. pilostyla* subsp. *austrina*, *P. pilostyla* subsp. *syntoma* and *P. prostrata*, and for two species that are now more narrowly circumscribed, *P. brevifolia* R. Br. and *P. longifolia* R. Br. A lectotype is also selected for *P. longifolia*. Pollen presenter characters, which are of particular importance in this group, are compared in a table and are illustrated for all of the named taxa.

Introduction

In a recent paper (Hislop & Rye 2002) dealing with three new species of *Petrophile* R. Br., it was noted that the PERTH collections of both *Petrophile brevifolia* and *P. longifolia* were heterogeneous and needed further study. One of the variants of *P. brevifolia* had already been placed under the manuscript name *P. latericola* Keighery and a variant of *P. longifolia s. lat.* was allocated the informal name *Petrophile* sp. prostrate (*J.W. Horn & R. Butcher* 2649). The aim of the present study was to examine type material of members of this species group to establish the correct application of the published names, and to describe any taxa in the group that proved to be new or significantly altered in their circumscription. A further aim was to provide a key to all of the named taxa, and details and illustrations of the pollen presenters as a further means of identifying them.

As noted by George (1998), recent works have not established an updated infrageneric classification for *Petrophile*. The species examined here belong to *Petrophile* sect. *Arthrostigma*, one of four sections that were delimited informally by Brown (1810b) and one of six sections recognised by Bentham (1870). Although this old classification needs some modification to incorporate all of the species currently recognised, section *Arthrostigma* appears to be a natural group and hence a suitable one to examine as a whole in the current study. Other named sections in the genus mostly appear to be less well defined. They include a number of new species which will be treated in a later paper.

For those members of *Petrophile* sect. *Arthrostigma* that are not described here, descriptions are available in Foreman's (1995) treatment of the genus in Volume 16 of "Flora of Australia" or in Hislop & Rye (2002). Continually updated distribution maps are available for all taxa on FloraBase (Western Australian Herbarium, 1998 onwards).

Materials and methods

Measurements and conservation status. Similar methods were used in this study to those described in our earlier paper (Hislop & Rye 2002).

Interpretation of the type localities. Brown (1810a,b) named a number of species of *Petrophile* based on his collections made from King George Sound and other coastal localities. In a later work, Brown (1830) based additional new taxa in the genus on Baxter's specimens from 1828–1829, in every case giving the locality as "ora occid.-merid., King George's Sound". However, on the label of each specimen examined here, the locality is recorded vaguely as the south-west coast of New Holland. Unlike Robert Brown, William Baxter collected his specimens not only on the coast but also at least as far inland as the Stirling Range. Evidence for this is that his specimens include *Petrophile anceps* R. Br., a Stirling Range endemic.

It appears that *Petrophile* taxa represented at King George Sound were all or mostly named by Brown based on his own collections whereas the ones he named later were mostly those occurring further inland or on the coast further east and hence not available to him until he was able to use Baxter's specimens. The type localities for Baxter specimens given in the current study as "Stirling Range to the south coast" would therefore mostly not have been collected exactly at King George Sound but somewhat inland or further east of the sound.

Descriptions and key

Petrophile section **Arthrostigma** (Endl.) Benth., Fl. Austral. 5: 321 (1870). – *Petrophile* sect. I. R. Br., Prod. 364 (1810). – *Petrophile* a. *Arthrostigma* Endl., Gen. Pl. 337 (1837). *Type: Petrophile teretifolia* R. Br., lectotype here designated.

Leaves simple, narrow, terete or compressed, obtuse to pungent-pointed. *Inflorescences* more or less sessile, compact; involucral bracts and cone scales not viscid, completely glabrous or ciliate in most taxa. *Tepals* separating fully, becoming spirally twisted, white to yellow or pinkish outside, glabrous inside, not viscid; claw glabrous at base, the remainder densely hairy; limb often darker than the claw and often brownish or greyish, hairy throughout or with longitudinal subglabrous stripes, without a distinct terminal glabrous appendage. *Pollen presenter* often minutely papillose, with a distinct glabrous base below the brush; base turbinate to very narrowly obovate, usually truncate at summit, often prominently 4-ridged; brush rather sparsely hairy to very dense, with a more or less cylindric axis distinctly narrower than the truncate summit of the base (except in *P. antecedens*) but the whole of it (including the hairs) as broad or broader than the base, the hairs acute to distinctly clavate. *Nut* small (2–3.5 mm long), compressed but not winged, with a coma of very long marginal hairs, the two surfaces shallowly and often unequally convex, with short hairs at least along the midline of each surface and often also some much larger hairs.

Size and distribution. Endemic to the south-west of Western Australia, with 17 named species, two of which have subspecies, giving a total of 20 taxa. One additional species is known by a manuscript name.

Common names. Probably the best known species in the section is Pixie Mops, *Petrophile linearis*, which is common on the Swan Coastal Plain including the remnant bushland of many Perth suburbs. This species is illustrated in Rye (1987: Figure 128). Very few other members of the genus have common names.

History and lectotypification. Brown (1810b) included three species, *P. teretifolia*, *P. filifolia* and *P. acicularis*, in his *Petrophile* sect. I, and all three species match his description of the section in all details. The first species listed, *Petrophile teretifolia*, is selected here as the lectotype of the section. Endlicher (1837) named the group *Arthrostigma*, but without specifying the rank, and did not include any additional species. Bentham (1870) specified the sectional level for the group and added five species that had been named by Brown (1830), these being *P. anceps* R. Br. [as *P. linearis* var. *anceps* (R. Br.) Benth.], *P. juncifolia* R. Br. [as *P. media* var. *juncifolia* (R. Br.) Benth.], *P. linearis* R. Br., *P. media* R. Br. and *P. longifolia*.

Recently, descriptions and illustrations of five additional members of the section, *P. antecedens* Hislop & Rye, *P. aspera* C.A. Gardner ex Foreman, *P. clavata* Hislop & Rye, *P. helicophylla* Foreman and *P. nivea* Hislop & Rye, have been published (Foreman 1990, Hislop & Rye 2002). However, these and other recent works have not used, nor even discussed, any infrageneric classification for the genus. It would appear from the systematic arrangement of the species of all members of the genus by Foreman (1995) that he considered the two species with uniformly compressed leaves not to be closely allied to the other members of the group, although he placed all other members of sect. *Arthostigma* together. Apart from this single character difference in the leaves, there appears to be no basis for separating these two taxa into a separate species group, and it should be noted that *P. megalostegia* F. Muell. also very rarely has compressed leaves.

Pollination. Four species of native bees have been recorded visiting the flowers of *Petrophile linearis* (Houston 2000). The significance of the very varied pollen presenters in *Petrophile* species may be related to pollinator specificity but this remains to be studied.

Distinguishing characteristics. Sect. *Arthrostigma* is distinguished from other sections of *Petrophile* by a combination of the characters given above, especially by its pollen presenter shape and brush. The brush generally has larger hairs than in the other sections, with the hairs sometimes so dense that the brush axis is completely obscured. Sect. *Xerostole* (*P. biloba* R. Br., *P. heterophylla* Lindl., *P. squamata* R. Br. and *P. striata* R. Br.) has the pollen presenter of a similar shape (although tending to be more fusiform in *P. biloba*) but with the upper part either glabrous or sparsely hairy with very short hairs. In the other sections the pollen presenter is more or less fusiform. Members of these sections have small, often very sparse hairs, which commonly extend more or less for the entire length of the pollen presenter. Generally, although the term 'brush' is applied to the hairy portion in these other sections, it is mainly in sect. *Arthrostigma* that the hairy portion is really brush-like in appearance.

It is also the only section in which all species have simple entire leaves, and most species have glabrous involucral bracts and cone scales. In the other sections divided and/or toothed leaves are common and the only species outside sect. *Arthrostigma* that has glabrous bracts is *Petrophile carduacea* Meisn. In other species the bracts are invariably hairy, at least on the margins or inside, and are sometimes viscid.

Tepal characters may also be significant. In sect. *Arthrostigma*, the tepals separate to the apex when the flower opens, the claw of each tepal is densely hairy outside except at the base and the apical appendage of the limb is always hairy. In other species groups the tepal claws are sometimes glabrous or not very densely hairy, many species have a long glabrous apical appendage on each limb, and in some species the tepals are shed together.

Variation within the section. Growth habits vary within the section from strictly prostrate, as in *P. helicophylla* Foreman, to erect and up to 2 m tall in *P. teretifolia* R. Br. Some taxa appear to be very variable in habit, particularly *P. brevifolia s. lat.* which varies from low and widely spreading to 2 m tall. *P. brevifolia* is also the most variable species in other respects and it needs further study to determine whether infraspecific taxa or additional species need to be recognised. Some taxa (e.g. *P. linearis* R. Br.) have a lignotuber while others (e.g. *P. teretifolia*) do not and are killed by fires (George 1984).

Petrophile anceps and *P. linearis* can generally be distinguished readily from other members of the section by their flattened rather than terete leaves. One odd specimen of *P. megalostegia* (*E.A. Griffin* 2183) differs from all the rest in having flattened leaves like those of *P. linearis*. However, in all other characters it is typical of *P. megalostegia* and so does not appear to be a hybrid between these two taxa but just an exceptional member of the former species.

The two very closely related species *Petrophile antecedens* Hislop & Rye and *P. clavata* Hislop & Rye can be readily distinguished from other members of sect. *Arthrostigma* by their hairy stems and involucral bracts. *P. antecedens* is also atypical of the section in being the only species with a more or less fusiform pollen presenter. However there can be little doubt that it is closely related to *P. clavata* and the two species fit best within this group in other regards.

The cone scales are usually completely glabrous on both surfaces, but rarely may be somewhat hairy along the centre outside in a few taxa and are fairly commonly so in *Petrophile pilostyla* subspp. *austrina* and *syntoma*. The upper cone scales may also be ciliate in sect. *Arthrostigma*, as in *Petrophile teretifolia*, but are more often glabrous. Flower colour varies from white to a bright yellow and to pink-purple. The most common colour in the group is cream to pale yellow.

Of particular importance in distinguishing the taxa in this section are the many characters relating to the pollen presenter, which in some taxa is so distinctive as to be unique in the genus. Figures 1 and 2 illustrate the pollen presenters of all currently recognised members of this section. Table 1 compares a good number of these pollen presenter characters among the members of sect. *Arthrostigma*. Additional characters of significance include the density of the brush and the colour and shape of the base.

Notes. Authorship of this section, given as *Petrophile* sect. *Arthrostigma* (Endl.) Kuntze, was incorrectly attributed by Chapman (1991: 2222) to Kuntze (1904: 427), who was simply following the much earlier treatment by Bentham (1870). Bentham similarly treated two other names that Endlicher had erected for groups of unspecified rank in *Petrophile*, these becoming sect. *Symphyolepis* (Endl.) Benth. and sect. *Xerostyle* (Endl.) Benth., although he neglected to cite Endlicher's name for the latter. While it could possibly be argued that he had named a new section *Xerostyle*, it is clear from his use of Endlicher's name and his referral to Endlicher in other parts of his treatment, that this was just an accidental omission and should not be regarded as the naming of a new section.

Key to the species and subspecies of *Petrophile* sect. *Arthrostigma*

1. Leaves flattened
  2. Involucral bracts ovate or almost elliptic, the upper ones acute. Tepals yellow and *c.* 30 mm long. (Mullewa to Badgingarra.) ..... **P. megalostegia** (atypical)
  2. Involucral bracts linear-subulate, acuminate. Tepals either pink-mauve or *c.* 15 mm long

3. Tepals *c.* 15 mm long, yellow. Pollen presenter brush with obtuse or slightly clubbed hairs 0.15–0.2 mm long. (Stirling Range.) ..... **P. anceps**
3. Tepals 25–35 mm long, pink-mauve. Pollen presenter brush with acute hairs 0.3–0.5 mm long. (Dongara to Scott River.) ..... **P. linearis**

1. Leaves terete
4. Branchlets densely hairy; involucral bracts densely hairy at base. Pollen presenter brush sparsely hairy with distinctly clubbed hairs, the axis clearly visible
5. Pollen presenter 1.5–2.2 mm long, the swollen portion more or less fusiform and partially hairy, the glabrous base about as long as the brush. Involucral bracts conspicuously brown above the grey-hairy base. (York to Harrismith.) ..... **P. antecedens**
5. Pollen presenter 3–4 mm long, the swollen portion very narrowly turbinate, glabrous and much longer than the more cylindrical brush. Glabrous part of involucral bracts more slender and less conspicuous than in *P. antecedens*. (Alexander Morrison National Park to Calingiri.) ..... **P. clavata**
4. Branchlets and involucral bracts glabrous. Pollen presenter brush either very dense, the axis obscured by the very numerous hairs, or with hairs acute or obtuse
6. Pollen presenter brush very dense, the axis obscured by very numerous hairs which are usually all clubbed (rarely some obtuse in *P. longifolia*)
7. Strictly prostrate plants with erect spirally twisted leaves. Pollen presenter 6.3–7.5 mm long. (Pingrup to Newdegate to Ravensthorpe.) ..... **P. helicophylla**
7. Prostrate to erect plants with straight to slightly twisted leaves. Pollen presenter 3–5.5 mm long
8. Leaves coarsely scabrous. Occurring inland (Narrogin to Lake Grace) ..... **P. aspera**
8. Leaves smooth or very finely scabrous. Occurring on or near the south coast
9. Upper cone scales (in flower) ciliate. Tepals pink-mauve turning whitish. Brush of pollen presenter 3–4 mm long, more than twice as long as base (Stirling Range to Israelite Bay.) ..... **P. teretifolia**
9. Cone scales entire or denticulate. Tepals cream or yellow. Brush of pollen presenter 2–3 mm long, usually 1–2 times as long as base
10. Growth habit very low and spreading to erect, the leaves surrounding the stems and flower heads. Flower heads held above ground level, 18–35(40) mm diam. (Stirling Range to Albany to Cheyne Bay.) ..... **P. longifolia**
10. Growth habit strictly prostrate, with the leaves congregated to one side of the stems and flower heads. Flower heads held at ground level, (30)35–55 mm diam. (Jerramungup to Cheyne Bay to Fitzgerald River.) ..... **P. prostrata**
6. Pollen presenter brush sparse to dense, with the upper hairs acute; basal hairs acute except in *P. filifolia* where they are occasionally obtuse
11. Hairs on pollen presenter with a recurved apex. Cone scales very prominently striate; upper cone scales ciliate. (Scott River to Two Peoples Bay.) ..... **P. acicularis**
11. Hairs on pollen presenter patent or incurved. Cone scales not very prominently striate; upper cone scales ciliolate or glabrous

12. Involucral bracts brown throughout
13. Leaves very crowded, concealing the branchlets and involucral bracts, commonly 10–15 mm long, pungent. Tepals white. Pollen presenter brush sparse, with more or less patent hairs. (Near Eneabba.) ..... **P. nivea**
13. Leaves not so crowded as to obscure the branchlets and bracts from view, 110–300 mm long, not pungent. Tepals cream or yellow. Pollen presenter brush dense, with all or some hairs antrorse
14. Hairs on pollen presenter uniformly antrorse, straight. (Coastal plain from Perth to Busselton and northern Darling Range) ..... **P. juncifolia**
14. Pollen presenter with the basal hairs usually much more strongly antrorse than those above so as to give the appearance of a constriction between the base and the brush, the remaining hairs patent to widely antrorse and incurved
15. Tepal limb with a tight, uniformly antrorse indumentum 0.3–0.5(0.7) mm long. Pollen presenter with brush hairs 0.3–0.4 mm long. (Dryandra State Forest to Perup River to Albany and Stirling Range) ..... **P. filifolia** subsp. **filifolia**
15. Tepal limb with a loose indumentum of mostly patent and some widely antrorse hairs 0.7–1 mm long. Pollen presenter with brush hairs 0.5–0.8 mm long. (Armadale to Wandering) .... **P. filifolia** subsp. **laxa**
12. Involucral bracts grey throughout or partially grey
16. Involucral bracts ovate or almost elliptic, the upper ones shortly acute. Tepals *c.* 30 mm long. (Mullewa to Badgingarra.) ..... **P. megalostegia**
16. Involucral bracts very narrowly ovate, the upper ones long-attenuate. Tepals 10–25 mm long or rarely up to 33 mm long in *P. brevifolia*
17. Leaves 80–300 mm long, sometimes with a pungent point 0.5–1.5 mm long but more commonly not pungent
18. Leaves 80–150(220) mm long. Pollen presenter brush 1.5–2.3 mm long, moderately dense, with axis clearly visible; hairs 0.3–0.45 mm long. (Williams to Manjimup to Ravensthorpe.) ..... **P. media**
18. Leaves 150–300 mm long. Pollen presenter brush 2–3 mm long, dense, with axis partially hidden; hairs 0.5–0.7 mm long. (Coastal plain from Perth to Busselton and northern Darling Range) ..... **P. juncifolia**
17. Leaves 10–110 mm long, with a pungent point 1–3 mm long
19. Outer involucral bracts grey above a brownish base or grey throughout. Style sparsely to densely hairy at least in basal half or very rarely glabrous; expanded portion of pollen presenter without raised papillae although cell pattern may be evident
20. Tepals 9.5–12.5 mm long. Pollen presenter 4.5–5.5 mm long, about as long as or not much shorter than the remainder of style, which is very densely hairy. (Indarra area) ..... **P. pilostyla** subsp. **syntoma**
20. Tepals (10.5)12–18 mm long. Pollen presenter 3.5–5 mm long, much shorter than the remainder of style, which is glabrous to densely hairy
21. Cone scales glabrous to ciliate towards apex; longest cilia 0.1–0.25 mm long. Style densely hairy in lower half. (Tamala Station to Moresby Range to Yuna area) ..... **P. pilostyla** subsp. **pilostyla**

21. Cone scales ciliate or densely ciliate towards apex; longest cilia 0.25–0.4 mm long. Style glabrous to densely hairy in lower half. (Eneabba to Watheroo National Park.) ..... **P. pilostyla** subsp. **austrina**

19. Outer involucral bracts distinctly bicoloured, with a brown central stripe and grey margins. Style glabrous or very rarely with 1 or 2 hairs; expanded portion of pollen presenter minutely but distinctly papillose. (Irwin River to Perth to near Ravensthorpe.) ..... **P. brevifolia** complex (including *P. latericola* ms.)

Petrophile acicularis R. Br., *Trans. Linn. Soc. London* 10: 69 (1810). – *Protea acicularis* (R. Br.) Poir. *in* J.B.A.P. de M. de Lamarck, Encycl. Suppl. 4, 559 (1816). *Type citation:* "Lewin's Land, New Holland". *Type:* King George Sound, [Western Australia], December 1801, *R. Brown* (*lecto:* BM 0006232036, *fide* Foreman (1995: 474); *isolecto:* BM 000632033).

For a description of this species see Foreman (1995: 163). (Figure 1A)

Selected specimens examined. WESTERN AUSTRALIA: Boulder Hill, Pt 5455, Two Peoples Bay, 6 Oct. 1992, *A.R. Annels* 2620 (PERTH); Fishermen Rd, 8.4 km of road SE of beach at Broke Inlet, 21 Nov. 1990, *N. Gibson & M. Lyons* 873 (PERTH); King George Sound, *B.T. Goadby* B.2377, Oct. 1898 (PERTH); Torndirrup National Park, S of Albany, 28 Nov. 1986, *G.J. Keighery* 8815 (PERTH); Galamup Nature Reserve, 34°26'S, 116°46'E, 22 Oct. 1997, *G.J. Keighery & N. Gibson* 2251 (PERTH); King George Sound, Nov. 1909, *J.H. Maiden* (NSW); Stirling Terrace, King George Sound, 21 Sep. 1840, *J.A.L. Preiss* 626 (PERTH); Brockman Highway, E of Nillup, 30 Oct. 1948, *R.D. Royce* 3008 (PERTH); Nut Rd, *c.* 0.5 km N of junction with Ficifolia Rd, Walpole–Nornalup National Park, 16 Oct. 1991, *J.R. Wheeler* 2788 (PERTH).

Distribution and habitat. Extends along the south coast from the Scott River area east to Two Peoples Bay and inland to near Manjimup.

Phenology. Flowers recorded September to late November.

Notes. When Foreman (1995: 474) nominated the lectotype for this species, he gave "Lewin's Land" as the locality for this specimen (as given in Brown's (1810a) protologue) but gave "King George Sound" as the locality for a second specimen that had the Britten no. 3242, although the labels of both specimens indicate the same locality of King George Sound. Both were collected by Robert Brown in December 1801. Leeuwin's Land, given with a variety of spellings, was then used for the whole of the south-west corner of New Holland, including King George Sound. Brown's south-western Australian collections were from three localities, King George Sound, Lucky Bay and Goose Island Harbour (Vallance *et al.* 2001) but *Petrophile acicularis* occurs at only the first of these localities. It seems likely that the two sheets at BM were part of the same collection, and therefore the one with the Britten number 3242 is assumed here to be an isolectotype rather than a lectoparatype.

Petrophile acicularis differs from its closest relatives in having recurved hairs on the pollen presenter brush. The species is also generally recognisable by its very prominently striate cone scales.

Petrophile brevifolia Lindl., Sketch Veg. Swan R. 35 (1840). – *Petrophile media* var. *brevifolia* (Lindl.) Domin, *Vestn. Král. Ceské Spolecn. Nauk. Tr. Mat.-Prír.* 1921–1922(2): 2 (1923). *Type:* Swan River Colony [Western Australia, probably collected 1835–1838 by *J. Drummond*] (*holo:* CGE *n.v.*, photograph PERTH 01593382).

Shrubs regenerating after fire from a lignotuber and often multi-stemmed, sometimes with a combination of prostrate and erect stems, often widely spreading, commonly 0.2–0.5 m high, sometimes more erect and up to 1.5(2) m high. *Branchlets* prominently ribbed, grey, glabrous. *Leaves* usually mostly spreading or with at least some widely spreading below each flower head, well spaced to somewhat crowded, terete, straight to strongly curved or somewhat s-shaped, 25–100 mm long, 1–2.5 mm diam., glabrous; point pungent, 1–3 mm long. *Flower heads* usually few and mostly terminating branchlets, sometimes more numerous with lower ones fairly common, sessile, globose, 35–50 mm diam. *Involucral bracts* few to numerous, erect, subulate or very narrowly ovate, 8–15 mm long, acuminate, distinctly bicoloured at first with a brown thickened midrib contrasting with grey margins, becoming more uniformly grey with age, glabrous. *Cone scales* usually more or less ovate, 4.5–8.5 mm long, acute or acuminate, brown, nearly always glabrous outside, denticulate or entire, usually glabrous or with a few minute cilia near centre of each margin. *Tepals* 15–33 mm long; claw cream to medium yellow or pink-mauve, glabrous at base, with a very dense indumentum above of widely antrorse to patent hairs; limb 3.5–7 mm long, often somewhat more coloured than the claw, densely antrorse-hairy outside but sometimes with longitudinal glabrous or subglabrous longitudinal strips, the hairs 0.4–0.7 mm long. *Anthers* 2–3.3 mm long. *Style* glabrous or very rarely with one or several hairs. *Pollen presenter* 3.5–6 mm long; base 1.3–3.5 x 1–1.3 mm, 4-lobed, deep yellow turning orange or reddish, minutely but distinctly papillose; brush moderately dense (the axis visible), 1.3–3 mm long, 0.7–1.3 mm diam., when short then often not reaching summit of the thickened base, with a stout to moderately slender axis, which often tapers strongly from the base upwards, and numerous or fairly numerous patent or widely antrorse acute hairs 0.25–0.5 mm long; glabrous apical tip 0.4–1.3 mm long. *Cones* depressed globose to very broadly ovoid, 10–19 x 11–17 mm; scales broad, multi-ribbed but the ribs not always obvious. *Nuts* depressed ovate to very broadly obovate in outline, 2–3 x 2.5–4 mm, apex shallowly or very shallowly acute, the attached base of the style often forming a long point; abaxial surface with appressed or closely antrose white or rarely pale orange hairs *c.* 0.5 mm long very densely arranged along the middle and usually more scattered elsewhere, rarely also with long orange hairs at summit; adaxial surface with large orange to deep ferruginous hairs 3.5–4.5 mm long forming a prominent coma and very scattered to densely arranged on the surface. (Figure 1E,F)

Selected specimens examined. WESTERN AUSTRALIA: between Gingin and Regan's Ford, 22 Sep. 1962, *J.S. Beard* 1812 (PERTH); near Hinsa Hill, 13 miles [21 km] W of Merredin, *W.E. Blackall* (PERTH); Nature Reserve 16479, 25 km W of Jitarning, 12 Oct. 1984, *J.M. Brown* 014 (PERTH); Humphrey Rd, off Wyatt Rd, Gnowangerup, 15 Oct. 1990, *E.J. Croxford* 6444 (PERTH); 3 km N of Regans Ford, 14 Sep. 1995, *R. Davies* 102 (PERTH); Kings Park, 29 Nov. 1972, *P. Fairall* 2188 (PERTH); Capitella Rd, SE of Dandaragan, 30 Sep, 1998, *E.A. Griffin* 5356 (PERTH); Yardanogo Nature Reserve, 6.5 km S of Mt Adams, 13 Oct. 1989, *E.A. Griffin* 5557 (PERTH); Hi Vallee (property of D. & J. Williams), Warradarge, on W side of breakaway above creek, 23 Oct. 1999, *M. Hislop* 1781 (PERTH); Yarra Rd, 1 km S of Crawler Rd then *c.* 250 m W towards a granite outcrop, 9 Nov. 1998, *F. Hort* 307 (PERTH); Ningana Block, N of Pipidinny Rd, 3.5 km W of Wanneroo Rd, 12 Dec. 1990, *B.J. Keighery* 817B (PERTH); 11 km E of Cervantes, 21 Oct. 1990, *G.J. Keighery* 11872 (PERTH); Fowler's Gully, S end of Wongan Hills, *c.* 2 km S of Wongan Hills–Piawaning road, 29 Sep. 1985, *K.F. Kenneally* 9532 (PERTH); Eneabba, adjacent to golfcourse, 29 Oct. 1992, *A.M. Lyne* 953, *L. Craven & F. Zich* (PERTH); NE corner of junction of Jurien Bay Rd and Cockleshell Gully Rd, 11 Sep. 1999, *M. Puckridge* 88 (PERTH); race track E of rail reserve at SW boundary,

Corrigin, 18 Sep. 1995, *A. Saunders* CGN64 (PERTH); 0.5 mile [0.8 km] along Sappers Rd towards Karakin Rd, E of Lancelin, 29 Sep. 1966, *E.M. Scrymgeour* 1342B (PERTH).

Distribution and habitat. Irwin River south to Perth and south-east to near Ravensthorpe. On the coast between Mt Adams and Lancelin, *P. brevifolia* occurs in yellow, white or grey sand over limestone, in fairly exposed sites with low open shrubland, often with *Dryandra sessilis*. From Guilderton south to Perth it occurs in deep sand or in sand over limestone, in shrublands, *Banksia* woodlands or Tuart forest. Inland from these areas in the northern part of its range, the species is often a component of mixed heathland or very open mallee woodland, especially on lateritic uplands. In the south-eastern part of its range, between Tammin and Ravensthorpe, *P. brevifolia* is recorded in clayey or sandy soils, often with gravel or over laterite.

Phenology. Flowers from September to December.

Delimitation of taxa. The description given here for *Petrophile brevifolia* is a greatly reduced circumscription of the species in comparison with that accepted by Foreman (1995) and previous workers on the genus. However, even after the removal of the newly recognised species *Petrophile pilostyla* from amongst the material previously housed under *P. brevifolia s. lat.*, the specimens remain extremely variable and are referred to jointly in the key as the *P. brevifolia* complex. This complex includes *Petrophile latericola* Keighery ms., a taxon G.J. Keighery established for specimens occurring in a few populations at the base of the Whicher Range. These populations represent a significant disjunction for the *P. brevifolia* complex as a whole and differ from typical *P. brevifolia* in their short and usually rather erect leaves and ciliate cone scales, and in their non-lignotuberous habit.

However, specimens that match *P. latericola s. str.*, at least in having short erect leaves and ciliate scales, extend northwards along the Darling Range to the Mogumber area and then north to Arrowsmith River, although north of York the scales are often only very sparsely ciliate or glabrous. It remains to be seen whether the Darling Range and more northern specimens resemble the Whicher Range specimens in being uniformly non-lignotuberous and should be combined with it, but at least some of the northern populations are known to be non-lignotuberous. These short-leaved specimens (from Whicher Range and northwards), are referred to here as *P. latericola s. lat.* They possibly show some tendency to flower earlier and occupy more moist habitats than the other elements of the *P. brevifolia* complex.

Petrophile brevifolia and *P. latericola s. lat.* overlap in range in the region from York northwards but may be partially separated by the habitat and flowering time differences that were noted above. Both are very variable, each with several local variants, showing a pattern of variation that is especially complex in the northern sandplains, where the morphological differences listed above may not be sufficient to fully separate the two taxa. At the same time there is some specimen-based evidence to suggest that they may coexist in a specific area while maintaining these core differences. One mixed collection (*C.A. Gardner* 9296) made in August 1949 from near Dandaragan has a flowering specimen of *P. latericola s. lat.* and a non-flowering specimen that seems to match *P. brevifolia*, but there is no indication on the label as to how closely they were associated at this site.

Collections of *Petrophile brevifolia* (*F. & J. Hort* 1860) and *P. latericola s. lat.* (*F. & J. Hort* 1859) made in early October south of Badgingarra are especially noteworthy. They were collected *c.* 1.5 km apart in apparently similar habitats of heath on gravelly sandy soil. The morphological differences as

outlined above were quite clear between the two taxa there. *P. latericola s. lat.* had a tall erect growth habit and very pale yellow heads that were close to the end of flowering, whereas *P. brevifolia* had a low spreading habit and larger brighter yellow heads in early flower.

Further research is needed to determine how many taxa should be recognised formally within the *Petrophile brevifolia* complex. This probably needs to involve extensive fieldwork to establish which variants have a lignotuber, their respective flowering periods, whether and where the variants grow together and a close investigation of those sites where problematic collections have been made.

Type locality. The type material of *Petrophile brevifolia* was collected prior to 1840 in the Swan River Colony, which may by then have been explored as far as the Moore River in the north, York in the east and the Murray River to the south, but is most likely to have come from close to the Swan River Estuary. Its leaves, with a maximum length of *c.* 35 mm, could fit any of the members of the complex as they are near the short extreme of the 30–100 mm range of leaf length found in *P. brevifolia* and are longer than most specimens of *P. latericola s. lat.*, in which the leaves are generally 10–40 mm long. It can be concluded from Lindley's notes (1840) that the flowers were bright yellow like most of those found in Perth suburbs and surrounding areas, and from its spreading leaves that it is *P. brevifolia* rather than *P. latericola*, and it is probably the variant that is found on the Swan Coastal Plain. The type photograph and a more recent photocopy examined are clear enough to show the typical two-toned colouration of the bracts but not to discern details of the pollen presenter, which tends in the Swan Coastal Plain variant to have a more bushy brush with longer hairs than in other variants.

Notes. In addition to the typical variant of *Petrophile brevifolia* from the Swan Coastal Plain, the variants in this extremely variable species include a pink-flowered one on coastal limestone between Mt Adams and Lancelin and a small-flowered one in the south-east, extending from Tammin to Ravensthorpe. The south-eastern variant tends to have short leaves, sometimes down to *c.* 30 mm long, short tepals down to 15 mm long and a short pollen presenter down to 3.5 mm long. The greatest variability, however, occurs in the northern sandplain areas, where the flowers are sometimes very large (expecially on *E.A. Griffin* 3266) and the pollen presenter is up to 6 mm long.

Throughout the species range, most specimens are low but some are 1 m or more, the maximum height recorded being 2 m for one of the specimens from the Wongan Hills (*K.F. Kenneally* 9532). Leaf thickness varies considerably, often on a single specimen, and one with particularly thick leaves is *W. Greuter* 22393. The cone scales are nearly always glabrous outside but *R.D. Royce* 9754 has them hairy outside at the centre and glabrous around the margin. The style is completely glabrous in most specimens but a few northern specimens (e.g. *A.M. Lyne* 953, *L. Craven & F. Zich*) have one or several widely scattered hairs on the style.

Petrophile brevifolia may occasionally hybridise with the flat-leaved and pink-flowered *P. linearis* but the evidence is confused by the occurrence also of a pink-flowered variant in *P. brevifolia*. The pink- and yellow-flowered variants of *P. brevifolia* are not completely separated geographically and may coexist at a location near Dandaragan. A pink-flowered narrow-leaved specimen (*E.A. Griffin* 5357) collected there could possibly be a hybrid between a typical yellow-flowered *P. brevifolia* (represented by *E.A. Griffin* 5356) and *P. linearis* (represented by *E.A. Griffin* 5355), but is assumed here to be an isolated inland occurrence of the pink-flowered variant of *P. brevifolia*. A more likely intermediate between the two species is *B. Evans* WE 716 from Cockleshell Gully, also with pink flowers but with its leaves more flattened.

Petrophile filifolia R. Br., *Trans. Linn. Soc. London* 10: 69 (1810). *Type:* ora occid.-merid., King George Sound, [Western Australia], December 1801, *R. Brown* [*Britten* 3243] (*holo:* BM 000632034, 000632035).

Shrubs ascending to *c.* 0.5 m but usually lower, single-stemmed at ground level and probably always with a fire sensitive rootstock. *Branchlets* ribbed, glabrous, usually greyish brown at maturity, but younger branchlets pale brown or red purple. *Leaves* erect, terete, gently to strongly curved, (110)130–280 mm long, 0.9–1.5 mm diam., glabrous, usually smooth but very occasionally finely scabrous; apex a pale to dark brown, blunt or coarsely pungent, more or less uncinate mucro to 2 mm. *Flower heads* terminal on branchlets, sessile, mostly globose, less often depressed globose or broadly ovate, (20)25–45 mm diam. *Involucral bracts* usually few and rather inconspicuous, narrowly ovate to very narrowly ovate, acuminate, brown throughout but paler towards margins and apex. *Cone scales* obovate to broadly obovate, 6–11 x 4–6(7) mm, acute to acuminate, glabrous except for marginal tufts of antrorse hairs close to base and occasionally a few basal hairs on abaxial surface, brown, faintly ribbed, not or rarely becoming recurved. *Tepals* 17–25 mm long, usually cream or pale yellow throughout, rarely pink-tinged; claw glabrous at base, densely hairy above with an indumentum of widely antrorse to patent hairs; limb 3–4.4 mm long, densely hairy outside with either all hairs antrorse and 0.3–0.5 mm long or a mixture of patent and widely antrorse hairs 0.7–1 mm long. *Anthers* 1.8–2.9 mm long. *Style* glabrous. *Pollen presenter* 3.6–5.5 mm long, yellow turning orange; base 1–2.5 x 0.8–1 mm, usually quadrangular in cross section with thickened rounded angles, less often more or less terete; brush very dense 2.5–3.2 mm long (including glabrous tip), 0.8–1.3 diam., the axis usually concealed by the patent or widely antrorse, mostly incurved (occasionally only apical hairs incurved) and acute hairs (very occasionally the basal hairs blunt), the lowest hairs on the brush just above the base much more steeply antrorse than those above so as to give the appearance of a constriction at this point. *Cones* ovoid or broadly ovoid, 15–28 x 14–20 mm. *Nuts* usually broadly elliptic to elliptic in outline, less often broadly obovate or obovate, 1.8–3.2 x 1.5–2.8 mm including the acute style base; the abaxial surface usually glabrous but occasionally with a few antrorse hairs on the persistent style base, brown and often with 2 darker, elliptic markings on either side of the medial line; the adaxial surface densely covered by very short dark purple hairs overtopped by a moderately dense layer of golden-brown (possibly rarely white) antrorse hairs, which become denser towards the margin to form a conspicuous coma 2.5–4.5 mm long.

Distribution and habitat. Extends from Armadale south to Perup River and south-east to the Stirling Range and Albany. Occurs in a variety of habitats, often on winter-wet flats but also occurring in well drained habitats.

Phenology. Flowers mainly October to January.

Affinities. Petrophile filifolia was incorrectly placed in synonymy under *P. acicularis* by Bentham, who did still recognise the taxon under his new name of *P. longifolia* var. *tenuifolia*. Bentham (1870: 322) distinguished it from typical *P. longifolia* by its "Leaves longer and more slender, the cones and flowers smaller, the cone scales broader and less acuminate". Foreman (1995) followed Bentham in misplacing *P. filifolia* as a synonym of *P. acicularis*, but did not consider *P. longifolia* var. *tenuifolia* to be distinct, listing it as a synonym of *P. longifolia*. Certainly, Bentham's characters do not give a sound basis for the separation of these two taxa.

Confusion over the identity of this species may have resulted from some mislabelling of specimens, as a Robert Brown specimen (NSW 131386) from King George Sound labelled *Protea filifolia* does not match the BM type material of *P. filifolia*, but instead is *P. acicularis*. This specimen is definitely not an isotype of *P. filifolia* but could possibly be an isotype of *P. acicularis*.

Petrophile filifolia is reinstated here. It has a fairly wide range in the south-west, and overlaps with *P. longifolia* in the far south-east of its range. It tends to flower later in the year than *P. longifolia* and differs in having longer hairs on the pollen presenter. The basal hairs of its brush are generally closely antrorse whereas the remaining hairs are more spreading; this makes the pollen presenter appear to be somewhat constricted immediately above the expanded base. In contrast in *P. longifolia* there is no apparent constriction in the brush because all of the hairs are patent or widely antrorse. Brush hairs in *P. filifolia* are all acute or very occasionally the lowest hairs are obtuse, whereas those of *P. longifolia* are all clubbed or very occasionally the upper hairs are obtuse rather than clubbed. Apart from these pollen presenter differences, *P. filifolia* also has generally narrower cone scales and smaller nuts than *P. longifolia*.

Although the leaves of *Petrophile filifolia* are usually smooth, some specimens have finely scabrous leaves (e.g. *E.D. Kabay* 835) and these could possibly be confused with the coarsely scabrous leaves found in *P. aspera*. However, *P. aspera* also differs in pollen presenter details, having a characteristically short base (0.5–1 mm long) and proportionally long brush (3.4–4.8 mm long) with clavate hairs.

Notes. There are two main geographically distinct variants of *P. filifolia*, which are treated here as subspecies. They differ in minor indumentum characters of the tepals and pollen presenter brush.

a. Petrophile filifolia R. Br. subsp. **filifolia**

Petrophile longifolia var. *tenuifolia* Benth., Fl. Austral. 5: 322 (1870). *Type:* stony places, Kalgan River, [Western Australia], *A.F. Oldfield* 420 (*holo:* K, photograph PERTH 01543857).

Illustration. Blackall & Grieve (1988: 153) [as *Petrophile longifolia*].

Tepals cream or pale yellow; limb densely hairy with a tight, uniformly antrorse indumentum 0.3–0.5(0.7) mm long. *Pollen presenter* with brush hairs 0.3–0.4 mm long. (Figure 1H)

Selected specimens examined. WESTERN AUSTRALIA: Picnic area off Crapella Rd, Albany Highway, 20 km N of Kojonup, 5 Feb. 1997, *R. Davis* 2516 (PERTH); 0.5 km SW of Stirling Range National Park on Red Gum Pass Rd, 24 Sep. 1984, *D.B. Foreman* 839 (NSW, PERTH); between Unicup Lake and Kulunilup Lake, 34°21'S, 116°46'E, 2 Nov. 1977, *A.S. George* 15034 (PERTH); King George Sound, *B.T. Goadby* B.2375 (PERTH); Salt River Rd, Stirling Range National Park, 14 Oct. 1994, *E.D. Kabay* 835 (PERTH); 19 km NW of Wagin to Arthur River, 26 Nov. 1984, *G.J. Keighery* 7406 (CANB *n.v.*, PERTH); Millbrook Nature Reserve, 35 km NNE of Albany, 2 Nov. 1986, *G.J. Keighery* 8948 (PERTH); 50 km SE of Mayanup, 5 Nov. 1990, *G.J. Keighery* 12136 (PERTH); *c.* 62 km along Chester Pass Rd from Borden towards Albany, 3 Nov. 1992, *A.M. Lyne* 986, *L. Craven & F. Zich* (CANB *n.v.*, MEL *n.v.*, NSW, PERTH); Red Gum Spring, Stirling Range, Oct. 1963, *R. Rogerson* 55 (PERTH); Dryandra State Forest, 3 Nov. 1987, *D.M. Rose* 463 (PERTH); Drawbin Rd, *c.* 2 km off South Coast Highway, 25 Sep. 1982, *A. Strid* 20533 (PERTH).

Distribution and habitat. Extends from Arthur River and Dryandra State Forest south-east to the Stirling Range and Albany and as far east as the Hassell National Park. Also occurs in the Lake Muir to Tonebridge area. Occurs in dry or winter-wet sites usually on sandy soils, but also recorded in heavier soils, in heath or woodland.

Phenology. Flowers mainly October to January.

Notes. Two variants that are currently housed under this subspecies need further study to assess their taxonomic status. One consists of the somewhat disjunct south-western populations which, unlike their eastern counterparts, appear to be restricted to winter-wet habitats. These plants are apparently also taller with a more open growth habit. Another variant is known from two specimens collected in the Stirling Range (*B. Barnsley* 730, *R.J. Hnatiuk* 761436). This variant is typical of *P. filifolia* in all respects except that its pollen presenter lacks a definite constriction.

b. Petrophile filifolia subsp. **laxa** Rye & Hislop, *subsp. nov.*

A subspecies typica indumento tepalorum longiore laxiore, pilis in pollinis praebitor longioribus differt.

Typus: Brookton Highway, 1.55 km east of Omeo Rd, Clare State Forest, Armadale, Western Australia, 27 November 2000, *F. Hort* 1249 (*holo:* PERTH 05732956; *iso:* MEL).

Tepals usually cream or pale yellow, rarely pink-tinged; limb densely hairy with a loose indumentum of mostly patent and some widely antrorse hairs, 0.7–1 mm long. *Pollen presenter* with brush hairs 0.5–0.8 mm long. (Figure 1I)

Other specimens examined. WESTERN AUSTRALIA: Shulstaad Rd, 2.4 km E of the power lines then 250 m N on sand track, Leona State Forest, Wandering, 13 Nov. 2003, *F. & B. Hort* 2097 (PERTH); Brookton Highway, 8 km SE of Kinsella Rd, 1 Dec. 2004, *F. & B. Hort* 2437 (PERTH); Brookton Highway, along Canning River East *c.* 1 km WSW from Omeo Rd, 15 Dec. 2004, *F. & B. Hort* 2489 (PERTH); Barrett Rd, 2.3 km N of Wearne Rd, Wearne State Forest, Wandering, 14 Jan. 2001, *F. & J. Hort* 1270 (PERTH); Barrett Rd, 2.2 km N of Wearne Rd, Wearne State Forest, Wandering, 5 Mar. 2001, *F. & J. Hort* 1276 (PERTH).

Distribution and habitat. Known only from the Armadale to Wandering area of the Darling Range. Recorded from dry or winter-wet woodland or heath in sandy soils.

Phenology. Flowers between November and January.

Conservation status. Conservation Codes for Western Australian Flora: Priority Two. Known from about five relatively secure populations in State Forest.

Etymology. The subspecies epithet is from the Latin *laxus* – loose or open – referring to the characteristically open and spreading tepal indumentum.

Notes. The nearest known populations of *Petrophile filifolia* subsp. *filifolia* occur at Dryandra State Forest and in the Arthur River–Wagin area, *c.* 50 km to the south-east and 90 km to the south-south-east respectively, from the southernmost population of subsp. *laxa*. Plants from these areas are typical of subsp. *filifolia* throughout its range in respect to perianth indumentum and length of brush hairs. There are two collections from the Lake Unicup area east of Manjimup (*R.J. Cranfield* 16032 and *G.J. Keighery & N. Gibson* 2651) that approach subsp. *laxa* in having a longer, more spreading indumentum (to 0.7 mm) on the perianth limb. However the brush hairs are typical of subsp. *filifolia* and the limb indumentum is certainly denser than in subsp. *laxa*. All other collections at PERTH from these south-western populations have the perianth indumentum of the typical subspecies.

One recently collected specimen of this subspecies had pinkish flowers, but occurred in a population (*F. & B. Hort* 2437) where the usual cream or pale yellow colour predominated.

Petrophile juncifolia Lindl., Sketch Veg. Swan R. 35 (1840). – *Petrophile media* var. *juncifolia* (Lindl.) Benth., Fl. Austral. 5: 323 (1870). *Type:* Swan River, 1839, *J. Drummond* in Herb. J. Lindley (*holo:* CGE).

Illustrations. Blackall & Grieve (1988: 153) [as *P. media* var. *juncifolia*] and probably also the pollen presenter labelled "brush silky-hairy" [as *P. media* var. *media*].

Leaves 150–300 mm long, usually not pungent but often terminating in a slightly to very curved apical point 0.5–1(1.5) mm long. *Pollen presenter* 4–5 mm long; base 1–1.5 mm long; brush 2–3 mm long, 1.2–1.4 mm diam., dense, the axis partially hidden, with widely antrorse hairs 0.5–0.7 mm long. In other respects this taxon matches the description of *P. media* given in Foreman (1995: 164). (Figure 1K)

Selected specimens examined. WESTERN AUSTRALIA: Mundijong Rd, 200 m E of intersection with Kargotich Rd, 6 Nov. 1997, *R. Davis* 4453 (PERTH); Watershed Rd, 6.9 km S of Brookton Highway, 1 Nov. 1998, *F. Hort* 287 (PERTH); Twin Swamps Nature Reserve, Almeria Parade, 7 km N of Upper Swan, 10 May 1992, *B.J. Keighery & N. Gibson* 842 (PERTH); Fish Rd Nature Reserve, 13 km SW of Busselton, 3 Jan. 1991, *G.J. Keighery* 11588 (PERTH); 2 km N of Waroona, 23 Oct. 1992, *G.J. Keighery* 12231 (PERTH); Pinjarra, Murray River, 9 Oct. 1897, *R. Helms* (PERTH); Cannington, lower Canning River, 10 Aug. 1899, *A. Morrison* (PERTH); 30 km E of Perth at junction: The Lakes, Nov. 1920, *Wilson & Herbert* (PERTH).

Distribution and habitat. Occurs in winter-wet habitats on the coastal plain from Perth south to Waroona, with an isolated record from Busselton. There are also a couple of records from the Darling Range near Perth, where the species appears to grow in a drier habitat.

Notes. This species was reduced to a variety of *Petrophile media* by Bentham (1870) and then placed in synonymy under that species by Foreman (1995). It is reinstated here as it has significant differences in its pollen presenter measurements (see Table 1), also generally having longer leaves and a quite distinct distribution, with *P. juncifolia* in the north and west and *P. media* in the south and east. The differences between the two taxa are too great to treat them as varieties, but there is some doubt as to whether subspecific or specific rank is most appropriate for them.

The type specimen has a less hairy pollen presenter than usual in this taxon, with the hairs relatively short. One specimen that was reportedly collected within the range of *P. media* at Tambellup in January 1932 is typical of *P. juncifolia*, suggesting that the locality is incorrect.

Petrophile longifolia R. Br., Suppl. Prod. Fl. Nov. Holl. 5 (1830). – *Petrophile longifolia* var. *lorea* R. Br. *nom. illeg.* [= var. *longifolia*], Suppl. Prod. Fl. Nov. Holl. 5 (1830). *Type:* south-west coast of New Holland, [Stirling Range to the south coast, Western Australia], 1828–1829, *W. Baxter* (*lecto:* BM 000632028, here chosen; *isolecto:* NSW 131367).

Petrophile longifolia var. *caulescens* R. Br., Suppl. Prod. Fl. Nov. Holl. 5 (1830). *Type:* south-west coast of New Holland, [Stirling Range to the south coast, Western Australia], 1828–1829, *W. Baxter* (*holo:* BM 000623030).

Illustration. Figure 94H of Foreman (1995), which was drawn from *J.A.L. Preiss* 625 (MEL).

Shrub usually low and spreading or ascending but sometimes more erect, 0.25–0.5 m high, single-stemmed at the base and very erect at first, becoming divided into multiple spreading branches at or close to the base but probably always with a fire-sensitive rootstock. *Branchlets* sometimes yellowish brown and fairly smooth at first but soon becoming strongly irregularly ribbed and very dark red-brown, often glossy at this stage, eventually becoming grey, glabrous. *Leaves* mostly very dense and closely surrounding the flower heads, more distant on the non-flowering portion of the branches, terete, straight or more frequently gently to strongly curved, 150–350 mm long, 0.8–1.6 mm diam., glabrous; apex a dark, blunt or coarsely pungent, slightly uncinate mucro to 1.5 mm long. *Flower heads* terminal on branchlets, sessile, globose or depressed globose, 18–35 mm diam. *Involucral bracts* rather inconspicuous, ovate or narrowly ovate, acuminate, glabrous, yellowish brown to dark brown, thin and sometimes paler on margins. *Cone scales* broadly to depressed ovate, 7–10 x 5–9 mm, acute to acuminate, glabrous, medium to very dark brown, not or faintly ribbed, often becoming recurved. *Tepals* 11–18 mm long, cream or pale yellow throughout; claw glabrous at base, densely hairy above with an indumentum of widely antrorse to patent hairs; limb 4–5 mm long, densely hairy, the hairs antrorse and *c.* 0.5 mm long. *Anthers* 1.5–2.3 mm long. *Style* red and glabrous except for the pollen presenter brush. *Pollen presenter* 3–4.5 mm long; base 0.9–1.6 x 0.8–1.3 mm, angular and often distinctly flattened, usually with 4 more or less prominent longitudinal ribs, yellow turning orange; brush very dense, 1.9–3 mm long (including glabrous tip), 0.8–1.1 mm diam., the axis totally concealed by the patent or widely antrorse, incurved and clavate hairs (occasionally upper hairs blunt but unexpanded apically) 0.3–0.5 mm long, that so crowd the truncate apex of the base as to form the appearance of a solid outline between base and hairs. *Cones* mostly broadly or very broadly ovoid and 10–15 x 10–20 mm; scales with the distal portion clearly demarcated and often darker brown at maturity. *Nuts* with a very broadly obovate body topped by a triangular persistent style base, commonly 3–4.5 x 2–2.5 mm including the acute style base; the abaxial surface usually glabrous but occasionally with a few antrorse hairs on the persistent style base, brown and often with 2 darker, elliptic markings on either side of the medial line; the adaxial surface densely covered by very short dark purple hairs overtopped by a moderately dense or dense layer of golden-brown (possibly rarely white) antrorse hairs *c.* 2 mm long, and with a very dense longer indumentum of the latter hairs 2–4 mm long concentrated close to the margins to form a conspicuous coma. (Figure 2B)

Selected specimens examined. WESTERN AUSTRALIA: near Stirling Range, Oct. 1903, *C. Andrews* (PERTH); E of Cranbrook on N edge of Stirling Range,16 Oct. 1962, *T.E.H. Aplin* 2023 (PERTH); Warringup, Stirling Range, Sep. 1946, *A. Ashby* 1 (PERTH); Toolbrunup, Stirling Range National Park, 15 Sep. 1965, *A.C. Beauglehole* 12959 (PERTH); metal dump in reserve, Pfeiffer Rd, Manypeaks, 13 Aug. 1996, *E.J. Croxford* 7467 (PERTH); on the road to Bluff Knoll, 2 miles [3 km] in from highway, Stirling Range National Park, 27 Sep. 1966, *R. Filson* 8995 (PERTH ex MEL); King George Sound, Oct. 1898, *B.T. Goadby* B.2374 (PERTH); access track to Granite Hill Nature Reserve, 1.4 km E of Moorialup Rd at junction of a minor track, 16 Nov. 2003, *M. Hislop* 3086A,B (PERTH); S side of Millbrook Nature Reserve, *c.* 15 km N of Albany, 5 Nov, 1996, *A.R. Mast & D.S. Feller* 321 (PERTH); Reserve 13240, Cheyne Bay, N of Cape Riche, 24 Oct. 1996, *J.W. Mercer* 91 (PERTH); "Inter frutices densos planitiei subturfosae ad radices montis Wuljenup" Mt Wuljenup [Willyung Hill], Oct. 1840, *J.A.L. Preiss* 625 (MEL); 60 km NE of Albany on road to Jerramungup, 10 Nov. 1974, *D.J.E. Whibley* 5228 (PERTH); Hamilla Hill on Hancock Property 9 miles [14 km] along Salt River Rd from Cranbrook, Stirling Range National Park, 9 Oct. 1968, *J.W. Wrigley* (NSW).

Distribution and habitat. Extends from the northern edge of Stirling Range National Park south to Mt Willyung at Albany and east to Cheyne Bay. Recorded in sandplain and in sandy soils over laterite, in low woodlands dominated by *Banksia*, *Eucalyptus*, *Hakea* and *Acacia* spp.

Phenology. Flowers from mid August to early November. Fully mature nuts measured from *A.R. Mast*

& D.S. Feller 321 and *D.J.E. Whibley* 5228 for the southern variant and *C. Andrews* Oct. 1903 for the typical variant. Immature nuts can be identified readily by the large size of the style base in relation to the nut body and may have white rather than golden brown hairs, although it is possible some mature nuts also have white hairs.

Conservation status. Conservation Codes for Western Australian Flora: Priority Three. This taxon is possibly at risk as recent attempts to collect it were unsuccessful through most of its range. It has not been collected in the Stirling Range since 1968. Perhaps it is highly susceptible to fires, dieback or general disturbance. Certainly it needs to be monitored.

Type information. Brown (1830) listed two varieties under *P. longifolia*, the first given as *á. lorea* and the second as *ß. caulescens*, and did not indicate which of the two should be regarded as the typical variety. Two specimens of Baxter's at BM correspond with these two taxa. The one selected here as the lectotype of the species was originally identified as *Petrophile lorea* R. Brown ined., with a later identification as *P. longifolia* var. *lorea* added to the same label. A determinavit attached to this specimen by Foreman and dated 30 July 1990 states that it is the lectotype both of *Petrophile longifolia* and its var. *lorea*, but this intended lectotypification was not published in his flora treatment of the genus (Foreman 1995). The lectotype matches a number of PERTH specimens collected from the Stirling Range (e.g. *R. Filson* 8995) that have flower heads borne close to the ground and long erect leaves.

Affinities. See notes under *P. filifolia* which was previously considered [as *P. longifolia* var. *tenuifolia*] to be a variant of *P. longifolia*. If the two taxa had proved to be synonymous, it would have been necessary to adopt the older name *P. filifolia*. However, true *P. longifolia* and its variant *P. longifolia* var. *caulescens* apply to a distinct complex and are restricted to the Stirling Range to Albany and Manypeaks area. A third member of the complex, occurring further east, is named below as *P. prostrata*.

Notes. This taxon is variable in its growth habit. Some collectors record the habit as prostrate, but *Petrophile longifolia* is never truly prostrate, unlike its close relatives *P. helicophylla* and *P. prostrata*. Near Granite Hill Nature Reserve, between Porongurup and Manypeaks, a population was sampled (*M. Hislop* 3086A & B) comprising individuals that varied from very low and spreading (to *c.* 0.25 x 0.5 m) when growing in the open, to erect and up to 0.5 m high where in close competition with other plants.

Apart from this variability in growth habit there is a tendency for the northern collections from the vicinity of the Stirling Range to have larger floral parts and possibly a lower growth habit than those from farther south. These slight differences are the same as those observable between the type of *P. longifolia* and that of *P. longifolia* var. *caulescens* (with the former corresponding to the northern entity) and appear to form the basis of Brown's original separation. We have not observed *P. longifolia* in the Stirling Range area, where there have been no collections since the late sixties. However given the relatively slight and overlapping size difference in floral parts and the variability in growth habit noted above, the recognition of a second taxon here is not tenable at this stage. It should be noted that the larger-flowered Stirling Range specimens form the closest approach to the morphology of *P. prostrata* although still quite distinct in their habit and possibly also distinct in their nuts.

Petrophile media R. Br., Suppl. Prod. Fl. Nov. Holl. 5 (1830). – *Petrophile media* var. *typica* Domin *nom. illeg.* [= var. *media*], *Vestn. Král. Ceské Spolecn. Nauk. Tr. Mat.-Prír* 1921–22(2): 2 (1923). *Type:* south-west coast of New Holland, [Stirling Range to the south coast, Western Australia], 1828–1829, *W. Baxter* (*holo:* BM 000632031, 000632032).

Illustration. Blackall & Grieve (1988: 153), including the pollen presenter labelled "brush thinly hirsute" [as *Petrophile media* var. *media*].

Leaves up to 220 mm long but usually 80–150 mm long, usually not pungent but often terminating in a slightly to very curved apical point 0.5–1(1.5) mm long. *Pollen presenter* 3.5–5.5 mm long; base 1.2–2.3 mm long; brush 1.5–2.3 mm long, 0.6–1 mm diam., moderately dense, the axis clearly visible, with widely antrorse to patent hairs 0.3–0.45 mm long, the uppermost hairs sometimes much shorter than the rest. For other characteristics of this species see the description of this species in Foreman (1995: 164). (Figure 2C)

Selected specimens examined. WESTERN AUSTRALIA: Perup fire effects study plots, near corner of Northern and Boyup Brook–Cranbrook roads, *c.* 45 km E of Manjimup, 4 Nov. 1997, *A.R. Annels* 5986 (PERTH); 17.5 km SSE of Arthur River along Albany Highway, 23 Oct. 1983, *R.J. Cranfield* 4657 (PERTH); reserve, corner of Narrikup Rd and Albany Highway, 19 Nov. 1983, *E.J. Croxford* 5739 (PERTH); 2 km N of Narrikup, 31 Oct. 1995, *R. Davis* 259 (PERTH); 15 km along Koorong Rd from South West Highway, *c.* 42 km W of Ravensthorpe, 29 Nov. 1985, *D.B. Foreman* 1334 (PERTH); N of Mt Toolbrunup, Stirling Range, 13 Nov. 1069, *V. Mann & A.S. George* 139 (PERTH ex K); Mount Barker, Dec. 1898, *R. Helms* (PERTH); 65 km NE of Albany on Jerramungup road, 10 Nov. 1974, *D.J.E. Whibley* 5241 (PERTH).

Distribution and habitat. Extends from the Williams area south-east to Manypeaks and east-south-east to Ravensthorpe. Grows on a variety of soils in heath or open woodland in dry or winter-wet sites.

Affinities. Petrophile media has been confused with the species now known as *P. filifolia* and less frequently with *P. brevifolia*, although it shows greater similarities to the latter. *P. media* differs from *P. brevifolia* in its usually longer leaves and the more uniform colouration of its involucral bracts. Whereas the leaves of *P. brevifolia* are invariably pungent-pointed, those of *P. media* are more commonly blunt, the rather blunt point, when present, tending to be shorter and often on a strongly recurved apex. In *P. brevifolia* the inflorescence size is much more variable than in *P. media* but more uniformly globular in shape and the cone scales tend to be broader and shorter, and less obvious than the very numerous involucral bracts.

However, the closest relative of *Petrophile media* is *P. juncifolia*, which differs as described under that species. *P. media* was described as a very variable species by Blackall & Grieve (1988) and their illustration on page 153 includes three pollen presenters, showing the very hairy pollen presenter of *Petrophile juncifolia* [as var. *juncifolia*], and two pollen presenters labelled "brush thinly hirsute" and "brush silky-hairy" respectively for *P. media* [as var. *media*]. The thinly hirsute pollen presenter is typical of *P. media* but the silky hairy one appears to belong to *P. juncifolia*. There has clearly been some confusion between the two taxa as the range given by Blackall & Grieve for *P. media* incorrectly included Cannington, Pinjarra and Armadale, where only *P. juncifolia* occurs.

Notes. The type locality for *Petrophile media* was given as King George Sound by Brown (1830) but the specimen was probably collected a short distance away as there are no recent collections from that precise locality. The species is known from both north and east of King George Sound, for example at Narrikup and Manypeaks.

Two specimens (*R.J. Cranfield* 4657, *D.B. Foreman* 1334) of *Petrophile media* have unusually long leaves *c.* 220 mm long and one other specimen collected near the former specimen has leaves almost as long. All other specimens examined have leaves 80–150 mm long.

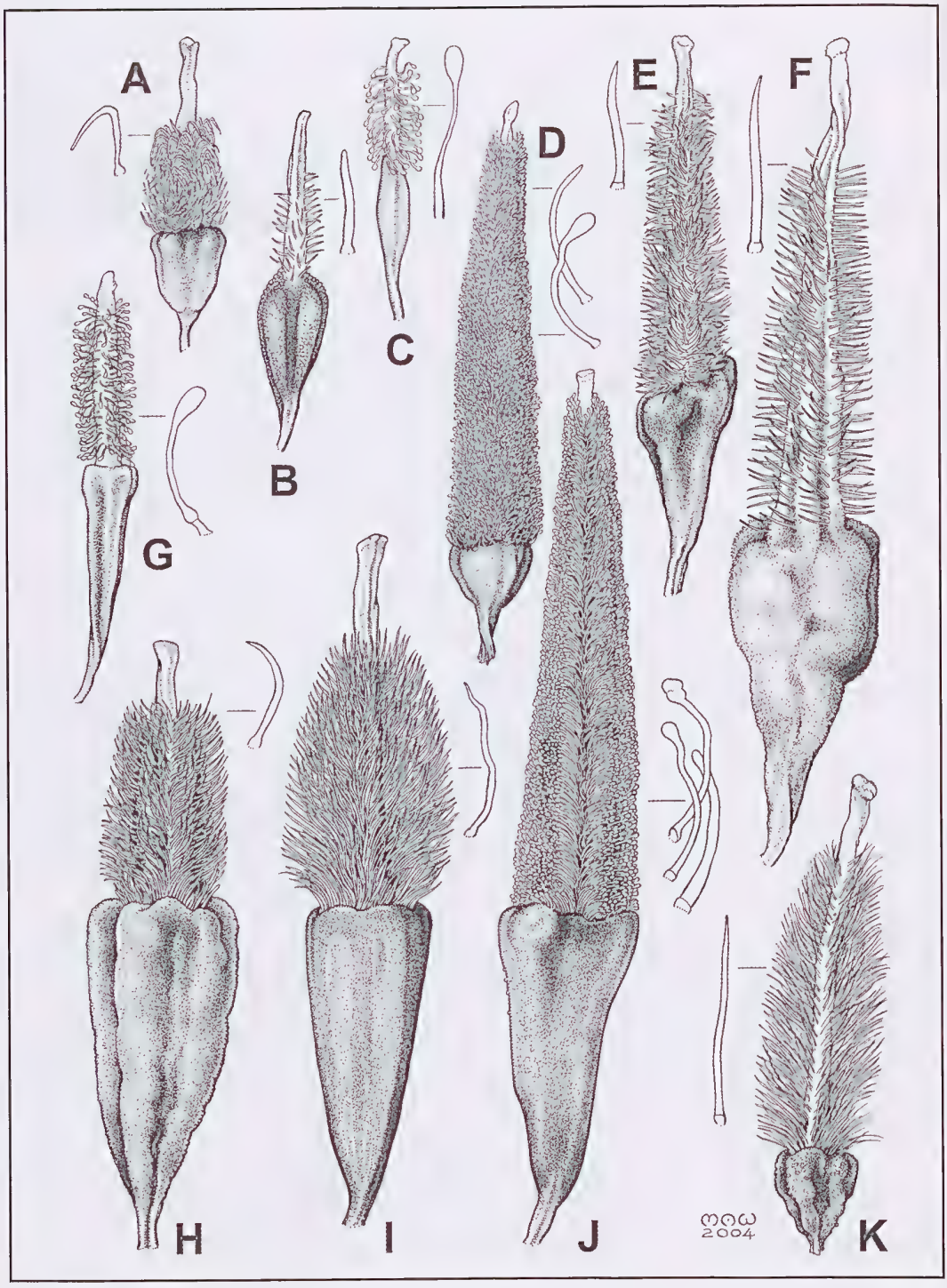

Figure 1. Pollen presenters with representative hairs enlarged. A – *P. acicularis*; B – *P. anceps*; C – *P. antecedans*; D – *P. aspera*; E, F – *P. brevifolia* complex; G – *P. clavata*; H – *P. filifolia* subsp. *filifolia*; I – *P. filifolia* subsp. *laxa*; J – *P. helicophylla*; K – *P. juncifolia*. Drawn by M. Wilson from *G.J. Keighery* 12175 (A), *T.E.H. Aplin* 2076 (B), *F. Hort* 1044 (C), *D.B. Foreman* 1125 (D), *P. Fairall* 2188 (E), *F. Hort & J. Hort* 1860 (F), *L. Polomka & S. Patrick* 4147 (G), *G.J. Keighery* 6717 (H), *F. Hort & J. Hort* 2097 (I), *F.H. Mollemans* 4401 (J) and *R. Davis* 4453 (K).

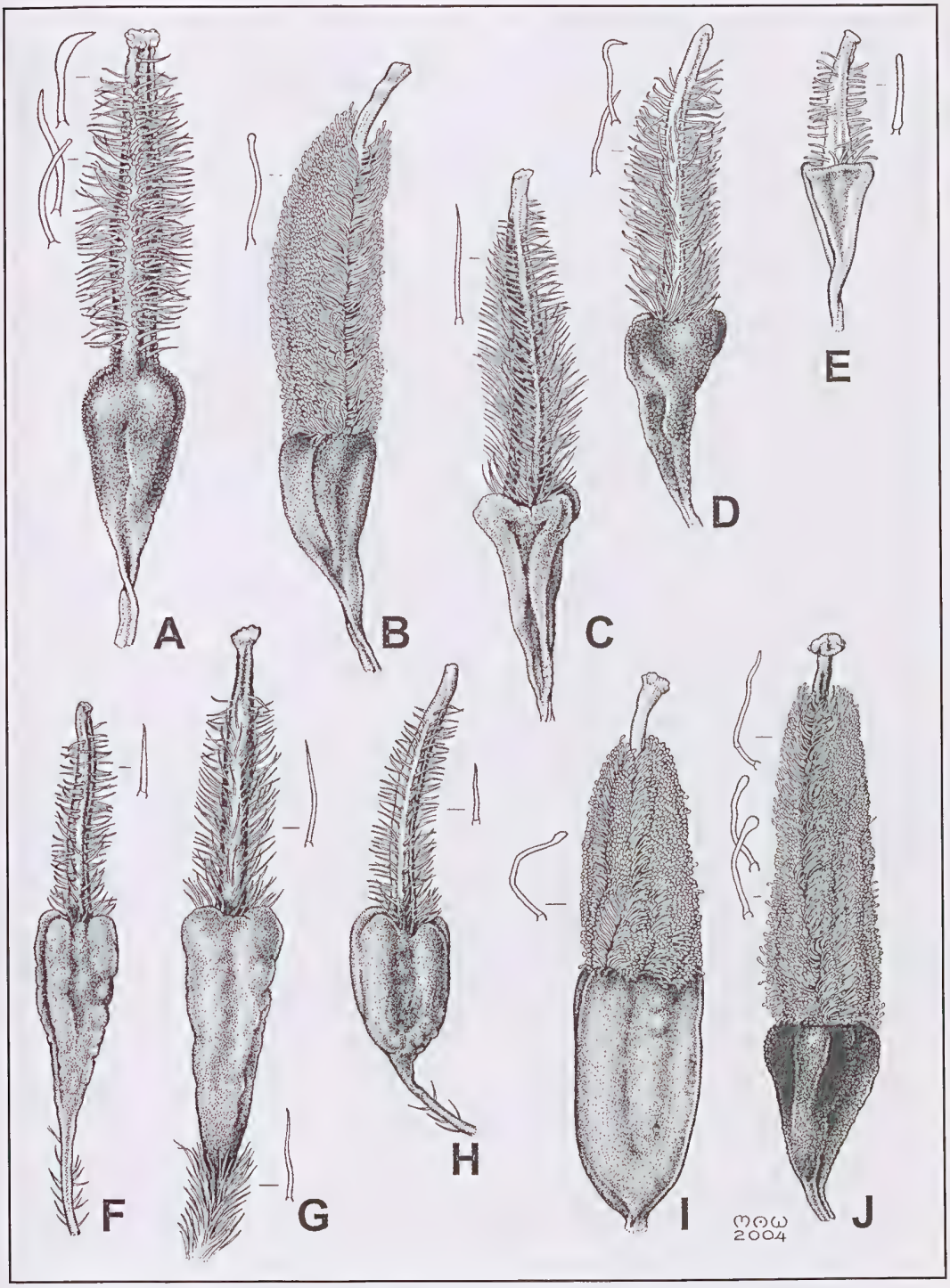

Figure 2. Pollen presenters with representative hairs enlarged. A – *P. linearis*; B – *P. longifolia*; C – *P. media*; D – *P. megalostegia*; E – *P. nivea*; F – *P. pilostyla* subsp. *austrina*; G – *P. pilostyla* subsp. *pilostyla*; H – *P. pilostyla* subsp. *syntoma*; I – *P. prostrata*; J – *P. teretifolia*. Drawn by M. Wilson from *S. Turner* 154 (A), *M. Hislop* 3086A (B), *A.R. Annels* 4115 (C), *B.J. Conn* 2062 (D), *M. Hislop* 2261 (E), *D.B. Foreman* 544 (F), *A.S. George* 9586 (G), *G. Stapp* 96 (H), *J.W. Horn & R. Butcher* 2649 (I) and *D.B. Foreman* 1432 (J).

Petrophile pilostyla Rye & Hislop, *sp. nov.*

Petrophile brevifoliae affinis sed bracteis involucri minus distincte bicoloribus, pollinis praebitor pilis tenuibis et axe gracilissimo, stylo piloso differt.

Typus: c. 0.5 km south of Binnu East Rd on Mongeragarry Rd, Western Australia, 19 Aug. 2003, *B.L. Rye* 238037 *& M.E. Trudgen*, (*holo:* PERTH 06744095; *iso:* K, MEL).

Illustration. Foreman (1995: Figure 94A) [as *Petrophile brevifolia*].

Shrubs single-stemmed at the base or becoming branched near or at ground level, 0.4–1.7(2) m high. *Branchlets* prominently ribbed, grey, glabrous. *Leaves* mostly spreading, not crowded, terete, straight to strongly curved or somewhat s-shaped, 40–110 mm long, 1–1.5 mm diam., glabrous; point pungent, 2–3 mm long. *Flower heads* terminating branchlets and also at lower junctions where the branchlets arise and then often appearing lateral, sessile, globose, usually 22–35 mm diam., occasionally appearing to be up to 50 mm wide when several heads are very closely associated. *Involucral bracts* few to numerous, erect, mostly narrowly ovate, 5–12 mm long, acuminate, glabrous, the inner ones pale brown either throughout or basally and grading into grey above, the outer ones usually grey thoughout or with brown restricted to the base. *Cone scales* almost elliptic to broadly obovate, 3–5 x 2.2–3.5 mm, acute, brown, longitudinally ribbed, glabrous outside or occasionally with a few hairs along the midrib, glabrous to densely ciliate on margins; ribs 7 or more at base, sometimes inconspicuous in flowering stage, becoming very prominent and tending to branch towards the thickened summit of the persistent portion; cilia 0.1–0.4 mm long. *Tepals* 9.5–17 mm long; claw cream or pale yellow, glabrous at base, with a very dense indumentum above of widely antrorse to patent hairs; limb 3.2–4.5 mm long, pale brownish or greyish, very densely antrorse-hairy outside, the hairs 0.2–0.4 mm long. *Anthers* 1.6–2.5 mm long. *Style* usually hairy, 0.3–0.8 mm long. *Pollen presenter* 3.5–5.5 mm long, deep yellow turning orange or sometimes reddish; base 1.5–3 x 1–1.5(1.7) mm, 4-lobed, sometimes with a few hairs towards the bottom and/or on the truncate summit; brush moderately dense (the axis visible), 2–3 mm long, 0.4–0.6 mm diam., with a slender cylindrical axis and numerous very fine patent or widely antrorse acute hairs 0.15–0.3 mm long; glabrous apical tip 0.3–0.5 mm long. *Cones* depressed globose or globose, 10–16 x 10–20 mm; scales broad, up to 15-ribbed. *Nuts* very broadly elliptic to depressed obovate (usually very broadly obovate) in outline, 2–3.5 x 2.5–3.5 mm not including style base, the attached base of the style often forming a long point; abaxial surface dark brown with paler margins, with appressed to closely antrose hairs 0.5–1 mm long very densely arranged along the middle and more scattered or largely absent elsewhere; adaxial surface with large golden brown hairs throughout and sometimes also a few much shorter dark purplish hairs towards the base, the largest marginal hairs 3–4.5 mm long forming a prominent coma.

Distribution. Extends from Tamala Station south-east to near Watheroo National Park, but with a disjunction of over 100 km in the known range of the species.

Phenology. Flowers mainly July to early September but also recorded as late as early October. Mature nuts measured on the type of subsp. *syntoma* and several specimens of each of the other two subspecies.

Etymology. From the Latin *pilus* –hair and *stylus* – style, as this species is the only member of *Petrophile* section *Arthrostigma* to have the style usually distinctly hairy. Species with hairy styles do occur in sections *Xerostole* (Endl.) Benth. and *Serrurioides* Benth.

Affinities. This species is usually readily distinguished from all other species in sect. *Arthrostigma* by

its distinctly hairy style, although there are a few specimens of one subspecies in which the style hairs are few or absent. It was previously included within the very broad circumscription of its close relative *Petrophile brevifolia*, but can be readily distinguished by its less distinctly bicoloured involucral bracts, which have intergrading brownish and grey portions or are brownish throughout. In *P. brevifolia*, the involucral bracts are generally more subulate and have a brown midrib contrasting strongly with the grey margins, although this distinctive bicoloured appearance may fade to a more uniform grey when the bracts age.

Flower colour in *P. pilostyla* is cream or very pale yellow, whereas *P. brevifolia* has pale to bright yellow flowers, or much less commonly, pale pink flowers. The as yet undescribed taxon *P. latericola s. lat.* (see discussion on page 473), commonly has very pale or pale yellow flowers, overlapping considerably with the flower colours of the other two taxa.

Petrophile pilostyla always has a slender axis and fine hairs on the pollen presenter brush, unlike true *P. brevifolia*, which has a thicker and often tapering axis to the brush and coarser hairs. *P. latericola s. lat.* is intermediate between these two taxa in its pollen presenter, showing some overlap with *P. pilostyla* but tending to have a paler base and nearly always with a broader and/or sparser brush. *P. pilostyla* is distinguished from both taxa, however, in its smoother enlarged base to the pollen presenter. In the other two taxa, the base is minutely but distinctly papillose. The top of the expanded base of the pollen presenter in *P. pilostyla* bulges upwards to enclose the base of the brush, resulting in the basal hairs of the brush being forced into an antrorse orientation. In the *P. brevifolia* complex the expanded base is more truncate or tapers at the top and there is sometimes a distinct gap between it and the base of the brush so that the brush hairs are generally all patent.

Differences in flowering time have been observed between *Petrophile pilostyla* and its closest relatives in the Warradage area, where they occur in close proximity. In that area, *P. pilostyla* subsp. *austrina* (*M. Hislop* 1355) commenced flowering first but overlapped in flowering time with *P. latericola s. lat.* (*M. Hislop* 2743), with typical *P. brevifolia* (*M. Hislop* 1781) coming into flower after both of the other species had finished. Although at this locality plants of *P. pilostyla* and *P. latericola s. lat.* grow side by side, no hybrids or intergrades have been observed there, nor have they been observed at any other localities.

Notes. There is considerable morphological variation in *Petrophile pilostyla*, with three main variants that are all geographically distinct. These variants show minor but significant differences in their morphology and are treated here as subspecies.

a. Petrophile pilostyla subsp. **austrina** Rye & Hislop, *subsp. nov.*

A subspecies typica squamis strobili plus ciliatis, distributio magis australi differt.

Typus: 'Big soak plain', south of Alexander Morrison National Park, 30°7'36"S, 115°32'30"E, Western Australia, 25 August 2002, *M. Hislop* 2726, *F. & J. Hort and D. & J. Williams* (*holo:* PERTH 05423708; *iso:* K, MEL).

Shrubs probably not fire-tolerant, 0.4–1 m high. *Leaves* 35–65 mm long; point 1–2.5 mm long. *Flower heads* 22–35 mm diam. *Cone scales* often with a few hairs along the midrib, glabrous to densely ciliate on margins; longest cilia 0.25–0.4 mm long. *Tepals* 10.5–18 mm long. *Anthers* 1.6–2.5 mm long. *Style* sparsely to moderately densely hairy in basal half or up to base of pollen presenter or very rarely glabrous;

indumentum 0.25–0.4 mm long. *Pollen presenter* 3.5–4.5 mm long, much shorter than the remainder of the style; base 1.5–2.2 mm long; brush 2–2.5 mm long. (Figure 2F)

Selected specimens examined. WESTERN AUSTRALIA: 2.9 km along road 40 from Carnamah–Eneabba road, 18 Sep. 1991, *R.J. Cranfield & P. Spencer* 8069 (PERTH); 3 km N of Mungedar turnoff on Badgingarra road, 31 Aug. 1984, *D.B. Foreman* 418 (PERTH); Marchagee Track, *c.* 27 km E of Brand Highway, 1 Sep. 1984, *D.B. Foreman* 480 (PERTH); on Carnamah road, 14 km E of Eneabba, 4 Sep. 1984, *D.B. Foreman* 524 (PERTH); on private farmland off Green Head–Coorow road, *c.* 3 km W of Brand Highway, 30 July 1995, *M. Hislop* 59 (PERTH); Hi Vallee (property of D. & J. Williams), near Warradarge, upland to north of main valley, 10 July 1999, *M. Hislop* 1355 (PERTH); in SW corner of Watheroo National Park, 6 Oct. 1971, *R.D. Royce* 9619 (PERTH); Tootbardi Rd, 2.1 km E of Brand Highway, 18 Aug. 2003, *B.L. Rye* 238006 & *M.E. Trudgen* (PERTH).

Distribution and habitat. Extends from the Eneabba area south to Badgingarra and inland to near Watheroo National Park. Recorded in low to tall shrublands on low hills and other somewhat elevated sites, mainly in white or yellow sand, often with lateritic gravel or over laterite, but some populations on grey sand. The shrublands tend to be rich in members of the Proteaceae, often with *Banksia* species dominant, but sometimes dominated by eucalypts such as *Eucalyptus todtiana*.

Etymology. From the Latin *austrinus* – southern, as this subspecies has a disjunct distribution south of the remainder of the species range.

Notes. This subspecies has shorter leaves on average than the other two subspecies. A specimen from Watheroo National Park (*R.D. Royce* 9619) has particularly short tepals 10.5–11 mm long, similar in size to those of subsp. *syntoma*, but its mature style is still much longer than the pollen presenter. The style is always at least sparsely hairy in the basal half in most populations but a few specimens (e.g. *D.B. Foreman* 418, *M. Hislop* 59) in the far east or south of the species range have a glabrous or very sparsely hairy style.

b. Petrophile pilostyla Rye & Hislop subsp. **pilostyla**

Shrubs with a stout basal stem that is probably somewhat fire-tolerant, 0.5–1.7(2) m high. *Leaves* 40–100 mm long; point 2–3 mm long. *Cone scales* glabrous or rarely with a few hairs along the middle outside, glabrous or ciliate on upper margins; longest cilia 0.1–0.25 mm long. *Tepals* 12–16 mm long. *Anthers* 2.2–2.5 mm long. *Style* moderately densely to densely hairy in basal half and usually for its full length up to base of pollen presenter; indumentum 0.3–0.6 mm long. *Pollen presenter* 4–5 mm long, much shorter than the remainder of the style; base 1.5–2.5 mm long; brush 2–2.5 mm long. (Figure 2G)

Selected specimens examined. WESTERN AUSTRALIA: Kirralee Farm, Brooke Rd, Ajana, 10 km E of North West Coastal Highway, 27 Aug. 2001, *G. & P. Allan* 55 (PERTH); Loop Rd, Kalbarri, 1 Aug. 1987, *D. & B. Bellairs* 1746 (PERTH); 22 km N of Yuna on the Dairy Creek–Gascoyne Junction road, 10 Sep. 1984, *D.B. Foreman* 638a (PERTH); 16 miles [26 km] SSE of Tamala Station Homestead, 27 Aug. 1969, *A.S. George* 9586 (PERTH); 6.5 km E on road from intersection with North West Coastal Highway, 1 km N of Binnu Railway Siding, 26 Sep. 1985, *N. Hoyle* 459 (PERTH); Zuytdorp National Park, 0.2 km from track that parallels coast from State Barrier Fence on track to Zuytdorp wreck site, 18 Aug. 1995, *G.J. Keighery & N. Gibson* 999 (PERTH); *c.* 1 km NE of Howatharra Hill Reserve, Moresby Range, 27 Aug. 1977, *N. McFarland & A. Weston* 1236 (PERTH); *c.* 0.5 km S of Binnu East Rd on Mongeragarry Rd, 19 Aug. 2003, *B.L. Rye* 238036 & *M.E. Trudgen* (PERTH).

Distribution and habitat. Extends from Tamala Station southwards in near-coastal areas to Moresby Range and inland (south-east) to the Yuna area. Recorded in low to tall shrublands, commonly on low hills and other somewhat elevated sites, mainly in white or yellow sand, often with lateritic gravel or over laterite, but the northernmost populations (Tamala area) in sand over limestone. The shrublands tend to be rich in members of the Proteaceae, often with *Banksia* species dominant, but sometimes dominated by eucalypts or *Actinostrobus arenarius*.

Notes. The typical subspecies has a considerably larger range than the other two subspecies, extending from Tamala Station to Moresby Range and East Yuna Nature Reserve. It tends to be a more robust and often taller shrub, up to about two metres high, with a thick base that appears to be fire-tolerant; however the tolerance to fire of all three subspecies needs to be investigated further. Its upper cones scales are commonly glabrous, whereas those of the other two subspecies are always ciliate, and when cilia are present in subsp. *pilostyla* they are short.

c. Petrophile pilostyla subsp. **syntoma** Rye & Hislop, *subsp. nov.*

A subspeciebus ceteris stylo breviore magis piloso, pollinis praebitor stylum reliquum aequans vel vix superanti.

Typus: Indarra Springs Reserve, along track from spring to eastern boundary, Western Australia, 26 September 1998, *G. Stapp* 172 (*holo:* PERTH 05775337).

Shrubs 0.5–1 m high, sometimes wider than high, with basal stem slender as far as known but largely buried so possibly somewhat fire-tolerant. *Leaves* 55–110 mm long; point 2–2.5 mm long. *Cone scales* often hairy along the middle outside, densely ciliate on upper margins; longest cilia 0.25–0.35 mm long. *Tepals* 9.5–12.5 mm long. *Anthers c.* 2.5 mm long. *Style* densely hairy; indumentum 0.6–0.8 mm long. *Pollen presenter* 4.5–5.5 mm long, about as long as or slightly shorter than the remainder of the style; base 2–3 mm long; brush 2.5–3 mm long. (Figure 2H)

Other specimens examined. WESTERN AUSTRALIA: 4 miles [6.4 km] W of Indarra, 27 Aug. 1965, *K.R. Newbey* 2160 (PERTH); Indarra Springs Nature Reserve, on Moore Rd, 10.4 km S of Geraldton–Mount Magnet road, 22 Aug. 2003, *B.L. Rye* 238109 *& M.E. Trudgen* (MEL, PERTH); Indarra Springs Reserve, along track to spring, 16 Sep. 1998, *G. Stapp* 96 (PERTH).

Distribution and habitat. Recorded near Indarra and in Indarra Springs Reserve (south of Mullewa). The most recent collection cited above was from the crest of a large sand dune, with bright yellow sand, the vegetation of scattered *Xylomelum* low trees over *Banksia* high shrubland. There are two other records of the subspecies occurring in yellow sand, at one location apparently occurring with *Allocasuarina campestris*.

Conservation status. Conservation Codes for Western Australian Flora: Priority Two. Subsp. *syntoma* appears to be very geographically restricted and may be endangered. At the most recent collection site for the taxon, about six dead plants were observed along the top of the crest of a sand dune, apparently killed by the drought conditions of the previous two years. A single surviving, but still drought-stressed, plant was found in a slightly more moist location a little below the top of the crest.

Etymology. From the Latin *syntomos* – shortened, referring to the short style.

Notes. Subsp. *syntoma* differs from the other two subspecies in its usually shorter tepals and always in its particularly short and very hairy style, the style indumentum both denser and longer than in the other two subspecies. Its pollen presenter is also longer on average and about the same length as the remainder of the style or not a great deal shorter. Subsp. *syntoma* is more like the southern subspecies in its densely ciliate cone scales but more like the typical subspecies in its long leaves.

There are not enough records to be sure of the habit and height range in subsp. *syntoma*, but the specimen collected during this study was a domed fairly dense shrub 0.55 m high and 0.8 m across. It had a basal stem *c.* 40 mm diam. buried in the sand and widening at ground level where it split into three main branches, two of them prostrate and the central one erect.

Petrophile prostrata Rye & Hislop, *sp. nov.*

Petrophile longifoliae affinis sed habito perfecte prostrato, foliis secundis et plerumque floribis grandioribus, coma in nuce longiore differt.

Typus: Collets Rd, 0.45 km west of Qualup Homestead Rd, Fitzgerald River National Park, Western Australia, 28 September 1999, *J.W. Horn & R. Butcher* 2649 (*holo:* PERTH 05645670; *iso:* DUKE *n.v.*)

Illustration. Foreman (1995: Figure 29).

Prostrate *shrub* 0.2–0.3 m high, with its height being equivalent to the length of its erect leaves, single-stemmed at the base at first as a small erect plant but soon dividing at ground level into multiple prostrate branches that are usually partially to fully covered by sand and spreading to a radius (or irregular width) commonly of 0.4–1 m diam. *Branchlets* glabrous, often bright red at first, usually soon distinctly irregularly ribbed and very dark red-brown, becoming more grey with age. *Leaves* sometimes crowded, erect and to one side of the stems and congregated to one side of each flower head, terete, often straight or fairly straight, less frequently gently to strongly curved, 200–320 mm long, 1–2 mm diam., glabrous; apex a dark, blunt or coarsely pungent, slightly uncinate mucro to 1.5 mm long. *Flower heads* terminating branchlets, horizontal to erect, usually at least semi-erect, sometimes separated from the leaves by a horizontal stem with moderately distant bracts, globose, (30)35–55 mm diam., the upper bracts short and broad. *Involucral bracts* often scattered along the stems for some distance below each inflorescence, ovate or broadly ovate, acuminate, glabrous, dark brown. *Cone scales* broadly to depressed ovate, 5–9 x 6–9 mm, acute to acuminate, glabrous, dark red-brown to very dark brown, not or faintly ribbed, apex sometimes becoming recurved. *Tepals* 18–27 mm long, cream or pale yellow throughout; claw glabrous at base, densely hairy above with an indumentum of widely antrorse to patent hairs; limb 5–7 mm long, densely hairy, the hairs antrorse and *c.* 0.5 mm long. *Anthers* 2–3 mm long. *Style* red and glabrous except for the pollen presenter brush. *Pollen presenter* 4–5.5 mm; base 1.5–2.2 x 1–1.3 mm, angular and often distinctly flattened, with 4–8 more or less prominent longitudinal ribs (often somewhat compressed on one surface and more ribbed on the other), deep yellow turning orange; brush very dense, 2–3.5 mm long (including glabrous tip), 0.9–1.2 mm diam., the axis totally concealed by the patent or widely antrorse, incurved and clavate hairs 0.3–0.4 mm long, that so crowd the truncate apex of the base as to form the appearance of a solid outline between base and brush. *Cones* mostly very broadly or depressed ovoid and 15–25 x 15–25 mm; scales dark brown, with upper portion clearly demarcated at maturity. *Nuts* broadly ovate to very broadly obovate, 3–4.5 x 2–3.5 mm including the acute persistent style base; the abaxial surface usually glabrous but occasionally with a few antrorse hairs on the persistent style base,

brown and often with 2 darker, elliptic markings on either side of the medial line; the adaxial surface densely covered by very short dark purple hairs overtopped by a moderately dense to sparse layer of golden-brown antrorse hairs commonly 2–3 mm long, with similar but larger hairs 4–6 mm long concentrated close to the margins to form a conspicuous coma. (Figure 2I)

Selected specimens examined. WESTERN AUSTRALIA: between Bremer Bay and Gordon Inlet, 3 Oct. 1981, *M.G. Corrick* 7774 (NSW, PERTH); just past Lake Magenta Rd, 75 km W of Ravensthorpe, 4 Nov. 1978, *R.J. Cranfield* 1002 (NSW, PERTH); Fitzgerald River National Park, 19.25 km SE of ranger's station on Quiss Rd, 6 Oct. 1988, *J.M. Fox* 88/198 (PERTH); between Hamersley River and East Mt Barren, 30 Sep. 1970, *B.R. Maslin* 871, 880 (PERTH); near Mt Groper in Reserve 14986, Cheyne Bay, N of Cape Riche, 28 Sep. 1996, *J.W. Mercer* 92 (PERTH); Hamersley Drive, 6.45 km NW of Moir Track, 9 Dec. 2003, *B.L. Rye* 231216 (PERTH).

Distribution and habitat. Extends from Jerramungup and the upper Corackerup Creek south to Mt Groper and south-east to near Hopetoun, including many localities in Fitzgerald River National Park. Occurs on white or grey sandy soils that are sometimes associated with laterite, granite or limestone, in low open heathlands or mallee shrublands and other shrublands, the dominant species often including *Banksia*, *Eucalyptus* and *Hakea* species. The most recent collection cited above was made from the summit of a broad rise, with scattered mallees over an extremely rich low shrubland/heathland with many Proteaceae species (including *Adenanthos*, *Grevillea*, *Isopogon* and *Petrophile*), Myrtaceae (including *Beaufortia*, *Melaleuca* and *Verticordia*), Epacridaceae, *Hibbertia*, *Boronia* and other shrub species over sedges.

Phenology. Flowers mainly from late August to mid November. Nuts measured on a number of specimens including *H. Demarz* 1090, *A.S. George* 10926 and *B.R. Maslin* 1007.

Affinities and notes. This taxon has been known by the informal name *Petrophile* sp. prostrate (*J.W. Horn & R. Butcher* 2649). A strictly prostrate growth habit is the main character separating it from *P. longifolia*. Both taxa have a single-stemmed base; this tends in *P. longifolia* to branch rapidly and semi-erectly, producing multiple erect flower heads over a fairly short distance, whereas in the new taxon the branching tends to be more distant and more divaricate with all stems strictly prostrate and the flower heads borne on the ground. On herbarium specimens the difference in habit is usually obvious, although the usually divaricate nature of the branching in *P. prostrata* can be hidden by the pressing process. The most reliable way to distinguish the two taxa from herbarium specimens is by the orientation and arrangement of the leaves adjacent to the flower heads as these surround the heads in *P. longifolia* but are concentrated to one side of the heads in *P. prostrata*.

No other complete differences between the two taxa have been confirmed, although the inflorescence and tepals of *P. prostrata* are usually larger and the cone scales are usually broader than in *P. longifolia*. The pollen presenter tends to be larger, with the base nearly always longer, and its brush hairs tend to be more obviously clubbed, but there are no absolute differences. Nuts are commonly present on specimens of *P. prostrata* but difficult to find on specimens of *P. longifolia*, and the coma on the nut is nearly always longer in *P. prostrata* than in *P. longifolia*.

A single seedling (*B.R. Maslin* 880) is represented among the herbarium specimens of this species. It is notable in its erect habit, in marked contrast to the mature plants occurring in the same population (*B.R. Maslin* 871). This seedling, on its own, would not be identifiable as the new taxon and suggests a closer relationship between this new taxon and typical *P. longifolia* than would appear to be the case

based on the very distinctive habit of the mature plants.

The distribution of *P. prostrata* is mainly to the east of that of *P. longifolia* but the two taxa overlap slightly in range, with both occurring in the Cheyne Bay area south-east of Wellstead (*J.W. Mercer* 91 & 92), where they appear to maintain their distinctiveness.

Table 1. Comparison of the morphology of the pollen presenter in the members of *Petrophile* sect. *Arthrostigma* (all measurements in millimetres).

Taxon	Pollen presenter length			Brush diameter	Hair length	Hair orientation and apex
	base	brush	total			
P. acicularis	0.5–0.7	1.5–2	2–2.5	0.5–0.7	0.2–0.4	recurved at apex, acute
P. anceps	1.3–2.8	2–2.8	3.2–5.4	0.5–0.7	0.15–0.2	patent, obtuse, straight
P. antecedens	0.5–0.8	0.8–1.2	1.5–2.2	0.5–0.7	0.2–0.3	patent, distinctly clubbed, straight
P. aspera	0.5–1	3.4–4.8	4–5.5	0.8–1	0.3–0.5	patent or widely antrorse, clubbed, incurved
P. brevifolia	1–3	2–3.1	3–6	0.7–1.3	0.25–0.5	patent or widely antrorse, acute, straight
P. clavata	1.3–2.3	1–1.5	3–3.6	0.6–0.7	0.2–0.3	patent, distinctly clubbed, straight
P. filifolia	1–2.2	2.5–3.2	3.6–5.5	0.8–1.3	0.3–0.8	patent to antrorse*, acute or obtuse, mostly incurved
P. helicophylla	1.8–2.2	4.3–5.1	6.3–7.5	1–1.2	0.3–0.4	patent, clubbed, incurved
P. juncifolia	0.8–1.8	2.4–3.5	3.2–5	1–1.4	0.5–0.7	antrorse or widely so, acute, straight
P. latericola ms.	1.1–2.2	0.9–2.5	3–4.5	0.4–0.9	0.15–0.4	patent or widely antrorse, acute, straight
P. linearis	1.6–2.7	2.1–3	4–6.2	0.8–1.4	0.3–0.5	patent, acute, straight
P. longifolia	0.9–1.4	1.9–2.7	3–4.4	0.8–1.1	0.3–0.5	patent or widely antrorse, mostly clubbed, incurved
P. media	1–2	2–3	3–5	0.6–1	0.3–0.45	widely antrorse or patent, acute, straight
P. megalostegia	1–1.8	2–3.2	3.5–4.8	0.8–1.3	0.3–0.5	more or less patent, acute, straight
P. nivea	1–1.3	1–1.3	2–2.8	*c.* 0.5	*c.* 0.2	patent, acute, straight
P. pilostyla	1.5–3	1.6–3	3.5–5.5	0.4–0.6	0.15–0.3	patent or widely antrorse, acute, straight
P. prostrata	1.4–2.5	2.2–3.5	3.5–5.5	0.9–1.2	0.3–0.4	patent or widely antrorse, clubbed, incurved
P. teretifolia	0.8–1.5	3–4	4–5.5	0.8–1	0.3–0.4	patent, mostly clubbed, incurved

* basal hairs more antrorse and straighter than other hairs.

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